(Additions) **WAC 173-340-200 Definitions.** For the purpose of this chapter, the following definitions shall apply:

"Habitat" means an area of land where animals or plants can live or feed.

"Ecoregion" means any of the ecological regions of Washington as defined in Omernik, JM. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77(1):118-125.

"Wildlife" means any non-human vertebrate animal other than fish.

"Soil biota" means invertebrate metazoan animals that live in the soil or in close contact with the soil.

"Natural vegetation" means any of the native plant communities described in *Natural Vegetation of Oregon and Washington*, J. F. Franklin and C.T. Dyrness, Oregon State University Press, or similar scientific botanical publications.

"Semi-natural vegetation" means a plant community in which the dominant species are native to Washington. Vegetated areas not considered natural or semi-natural vegetation include areas planted for ornamental or landscaping purposes, cultivated crops and areas predominantly covered by noxious, nonnative, exotic plant species or weeds.

"Native species" means species believed to have occurred in Washington prior to 1805.

"Terrestrial receptors" means plants and animals that live largely or entirely on land.

"Commercial" means....

"Threatened or endangered species" means species listed as threatened or endangered under the federal Endangered Species Act or state law (WAC 232-12-297).

(New section) **WAC 173-340-709 Ecological evaluation procedures.** (1) Purpose. This section defines the goals and procedures that the department will use to establish cleanup levels and support the selection of remedies which are protective of the environment.

(a) Goals. The overall goal of the ecological evaluation process is to protect terrestrial and aquatic species from significant adverse effects. For aquatic species, standards for significance are defined in state water quality and sediment regulations. For terrestrial species, population-level effects related to impaired reproduction, growth or survival are considered significant, except for threatened or endangered species listed under the federal Endangered Species Act or state law (WAC 232-12-297). For threatened or endangered species, an adverse impact would be "significant" if it causes harm to any individual member of the species or otherwise violates protections provided under the Endangered Species Act or applicable state laws.

(2) **Surface water evaluation.**

Surface water contamination shall be evaluated in compliance with requirements in WAC 173-340-730.

(3) **Wetland evaluation.** Wetland contamination shall be evaluated on a case by case basis in consultation with the department, including consideration of requirements in WAC 173-340-760.

(4) **Sediment evaluation.**

Sediment contamination shall be evaluated in accordance with WAC 173-340-760.

(5) **Terrestrial evaluation.** The following procedures shall be used to establish soil cleanup levels and support the selection of remedies which are protective of terrestrial species.

(a) Overview. The terrestrial evaluation is divided into three parts ("tiers"). For many sites, the Tier I evaluation may be sufficient to demonstrate that soil contamination does not present a threat to terrestrial species, and no further evaluation is required. If none of the Tier I criteria for making this demonstration apply, a Tier III evaluation may be required if any of the Tier III criteria listed in subsection (5)(b) apply. For a site that does not meet any of the Tier III criteria, either a Tier II or a Tier III evaluation may be conducted. The Tier II procedure is intended to be protective of terrestrial species at most sites, while the site-specific Tier III process for use at ecologically sensitive sites is intended to be highly likely to be protective at any site. It is expected that methods and approaches used in Tier II evaluations will be reasonably likely to protect terrestrial species from significant adverse effects. For Tier III evaluations, it is expected that the selected methods and approaches will be highly likely to protect terrestrial species from significant adverse effects. Cleanup levels developed in a Tier III evaluation need not necessarily be lower than Tier II screening levels provided in Table 6.

(b) Focus of the evaluation. Within intensively developed areas of industrial and commercial sites, the focus is protection of wildlife (terrestrial vertebrates). Within other areas the focus of the ecological evaluation process is on protection not only of wildlife but also plants and ecologically important functions of soil biota that support the reproduction, growth or survival of plants and wildlife.

(c) **Tier I.** Unless Ecology determines that special circumstances exist that require a more detailed evaluation, no further ecological evaluation of soil contamination is required if any of the criteria described in Table 4 are met.

(d) **Criteria for conducting Tier II or Tier III evaluations of soil contamination.** For sites that do not meet any of the Tier I criteria described in Table 4, either a Tier II or a Tier III evaluation shall be conducted. A Tier III evaluation, as described in subsection (5)(f) of this section shall be conducted if any of the criteria listed in subsection (5)(d)(i) of this section are met. If none of the criteria are met, a potentially liable person may elect to conduct either a voluntary Tier III evaluation or a Tier II evaluation.

(i) Tier III criteria. A site-specific ecological evaluation is required if any of the following conditions apply:

(A) The site is located on, or directly adjacent to, property where management or land use plans will maintain or restore areas of natural or semi-natural vegetation. (e.g., greenbelts, forestlands, locally designated environmentally sensitive areas, open space areas managed for wildlife, and some parks or outdoor recreation areas that are not used for intensive sport activities); or

(B) Known occurrence at the site of threatened or endangered species; wildlife species designated by Washington State Department of Fish and Wildlife as a "Priority Species" or "Species of Special Concern", or a plant species listed in the Washington State Department of Natural Resources Natural Heritage Program's "Endangered, Threatened, and Sensitive

Vascular Plants of Washington" publication; or

(C) The site is located on a property that contains at least ten acres of natural vegetation within 500 feet of the soil contamination, not including vegetation beyond the property boundaries; or

(D) The department determines that the site may present a risk to significant wildlife populations.

(e) **Tier II evaluation.** This evaluation procedure is intended to expedite decision-making at the majority of sites that do not meet any of the Tier I criteria in Table 4. The procedure is not intended to be appropriate in all circumstances. If there are special considerations that justify an alternative approach, a potentially liable person should consider conducting a voluntary Tier III evaluation in consultation with the department as provided for in subsection (5)(f) of this section. Special considerations include, for example, consideration of the net environmental effect of remedial decisions based on Tier II screening levels.

(i) Unless Ecology determines that special circumstances exist that require a more detailed evaluation, no further ecological evaluation of soils is required if any of the following criteria are met:

(A) The ecological exposure area is less than criteria provided in Table 5; or

(B) There are no potential exposure pathways from the soil contamination to soil biota, plants or wildlife. For a commercial or industrial property, only potential exposure pathways to wildlife (e.g., small mammals, birds) need be considered.

(C) The area of soil contamination is not more than 350 ft^2.

(D) The soil contamination does not include any of the substances listed in Table 6 at concentrations higher than the indicated screening levels, using the statistical methods described in subsection 173-340-740(7).

(E) Institutional controls. Use of Tier II criteria listed in (B) of this subsection requires the application of institutional controls to prevent future exposure of terrestrial receptors to soil contamination. Alternatively, soils may be cleaned to cleanup levels established using any of the options described in subsection 173-340-709(5)(e)(ii).

(ii) For sites that do not meet any of the Tier II criteria listed in subsection 173-340-709(5)(e)(i), a potentially liable person may elect to use Tier II screening levels listed in Table 6 as cleanup levels. Alternatively, methods developed by the department in consulatation with the Model Toxics Control Act Science Advisory Board may be used in place of Tier II screening levels to establish site-specific cleanup levels. A potentially liable person may also elect to conduct a voluntary Tier III ecological evaluation in consultation with the department, described in 173-340-709(5)(f). (See (5)(f)(iii)(H).)

(iii) Site-specific cleanup levels. For a commercial or industrial property a site-specific cleanup level is a soil concentration established for the protection of wildlife from significant adverse effects. For other land uses, a site-specific cleanup level is a soil concentration established for the protection of wildlife, plants and soil biota from significant adverse effects. Where an effects-based approach such as bioassay testing is used, areas of soil contamination failing the test may be defined in place of chemical concentrations.

(iv) Institutional controls. Cleanup remedies that rely on Tier II screening levels for industrial/commercial sites shall include appropriate institutional controls to

prevent future exposure to plants or soil biota in the event of a change in land use. To eliminate the requirement for institutional controls, alternatives include remediating to Tier II screening levels for unrestricted land use, or to site-specific cleanup levels developed in Tier II or Tier III.

(f) **Tier III ecological evaluation of soil contamination.**

(i) Tier III evaluations are intended for use at sites where a more careful assessment than for Tier II is required. The following apply to Tier III evaluations:

(A) Tier III evaluations may not be based on Tier II screening levels. Tier II screening values are developed from less conservative assumptions than are acceptable for Tier III sites. Cleanup levels developed in a Tier III evaluation may be higher or lower than Tier II screening levels, depending on site-specific considerations, such as contaminant toxicity or bioavailability.

(B) For evaluations conducted under a consent decree or agreed order, the approach and methods to be used shall be developed in consultation and with the approval of the department. The use of assessment and measurement endpoints, as defined in USEPA *Framework for Ecological Risk Assessment*, 1992, should be considered to clarify the logical structure of the evaluation. Assessment endpoints should be consistent with the policy objectives described in 173-340-709(1) and 173-340-709(5).

(C) Because Tier III evaluations involve qualitative decisions based on professional judgment and experience, the department expects persons conducting a Tier III evaluation to have relevant academic training in the biological sciences, such as ecology and toxicology, and previous experience in conducting site-specific terrestrial ecological risk assessments.

(ii) Problem formulation step. The scope and focus of a Tier III evaluation should be designed to provide information needed for remedial decisions. Examples of potential information include: whether soil contamination may present a significant risk to terrestrial ecological receptors; site-specific ecologically-based cleanup levels; areas of soil contamination requiring remediation for the protection of terrestrial ecological receptors. Preliminary remedial information such as measures to be taken for the protection of human health, may be considered, if available, in limiting the scope of problems to be addressed by the evaluation. For investigations conducted under a consent decree or agreed order, the scope and focus of a Tier III evaluation shall be determined on a site-specific basis in consultation and with the approval of the department. In defining the problems to be addressed by the evaluation, the department will, at a minimum, consider the following:

(A) Whether sufficient soil sampling data are available to adequately define the nature and extent of the soil contamination;

(B) Information obtained from a site inspection conducted by the department;

(C) Whether all existing and potential exposure pathways for ecological receptors at the site are identified in a conceptual site model;

(D) Whether the set of contaminants of potential ecological concern has been adequately identified for the site;

(E) The sensitivity of different existing and potential ecological receptors to the contaminants.

(F) Public concerns.

(G) Whether remedial plans for the site based on protection of human health or other considerations will leave residual soil

contamination that may potentially present a risk of significant adverse effects to terrestrial species.

(H) Whether the soil contamination may potentially present a significant risk to a threatened or endangered species.

(iii) Selection of contaminants of potential ecological concern. When conducting a Tier III evaluation at a site that is contaminated with numerous hazardous substances, a potentially liable person may narrow the focus of the evaluation to a smaller set of contaminants of ecological concern. If the department considers this approach appropriate for a particular site, the factors evaluated when eliminating individual hazardous substances from further consideration in the evaluation may include:

(A) A potentially liable person may elect to use chemical indicator concentrations to eliminate from consideration those substances where the maximum soil concentration of the hazardous substance does not exceed chemical indicator concentrations for the protection of plants, soil biota or wildlife. For plants, chemical indicator concentrations are those listed in *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision*, Oak Ridge National Laboratory, 1995. For soil biota, chemical indicator concentrations are those listed in *Toxicological Benchmarks for Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process*, Oak Ridge National Laboratory, 1995. For chemicals that are not listed, chemical indicator concentrations may be established using the methods described in those publications and in accordance with (5)(f)(v)(C) and (5)(f)(v)(D). For wildlife, screening concentrations calculated using the wildife exposure model described in (5)(f)(v)(A) should be used as chemical indicator concentrations. Caution on the use of chemical indicator concentrations for effects on plants and soil biota: These numbers are not cleanup levels, and exceedances do not necessarily require further action.

(B) The spatial distribution of concentrations of a hazardous substance exceeding concentrations established under subsections 173-340-(5)(f)(v)(A) are so limited that risks to terrestrial species are clearly insignificant. Possible reasons for retaining chemicals from such areas as contaminants of potential ecological concern could include: high concentrations present; potential for acute toxicity to wildlife; potential for the chemical to contaminate a larger area over time if unremediated (mobility); potential for the chemical to bioaccumulate.

(C) The hazardous substances is infrequently detected in soil samples (e.g., <5% of samples). The question of whether a detection may have come from a larger, unsampled area of contamination should be considered in applying this criterion. Additional sampling to resolve this issue may be appropriate if the detection indicates a high concentration of the chemical, or the chemical bioaccumulates.

(D) It is known that the contaminant is limited to an area that will be remediated (e.g., based on groundwater protection, risks to human health, etc.).

(E) Where there is early mutual agreement with the department that some areas of soil contamination will require remediation, it may be possible to use this information to narrow the list of contaminants of potential ecological concern. However, the substances thus

eliminated should be retained for discussion in the ecological evaluation report.

(F) There is a high spatial correlation with another hazardous substance of greater ecological concern that can serve as a surrogate for remedial decisions.

(G) Whether a substance is present at concentrations above natural background. Area background may not be used to eliminate a hazardous substance as a contaminant of potential ecological concern. However, area background may be considered in the selection of a cleanup action (WAC 173-340-360(6)(c)).

(H) For a site where a potentially liable person conducts a voluntary Tier III evaluation as provided for in subsection 173-340-709(5)(e)(ii) of this section, contaminants of ecological concern are the hazardous substances present in soil at concentrations above the screening levels shown in Table 6.

(I) Short-lived pesticides are not considered candidate contaminants of potential ecological concern if it can be shown through application records or other information that they have been properly applied in conformance with applicable label directions, laws and regulations

(iv) Site-specific approach. Following completion of the problem formulation phase of the Tier III evaluation, an appropriate approach for addressing issues identified in the problem formulation phase shall be developed. For investigations conducted under a consent decree or agreed order, the approach shall be developed in consultation and with the approval of the department. A record of the selected approach and the basis for the selection shall be prepared and made available to the public upon request. A site-specific approach may include, but need not be limited to, any of the following:

(A) The department may conclude that there is already sufficient information available to develop a cleanup remedy that is adequately protective of terrestrial ecological receptors;

(B) Based on an evaluation of the potentially affected ecological receptors, habitats and ecological communities potentially at risk, the department may agree to a request to conduct a Tier II evaluation at the site;

(C) A Level 1 (screening) approach may be used, as described in subsection (5)(f)(v);

(D) A Level 2 approach may be used, as described in subsection (5)(f)(vi).

(v) Level 1 (screening) approaches. Persons conducting a Tier III evaluation may elect to conduct a Level 1 assessment or to proceed to Level 2. Level 1 approaches are relatively faster, less expensive and do not require site-specific studies. Criteria such as biomarker effects used in a Level 1 approach need not be direct indicators of adverse effects on populations. Because Level 1 approaches require limited site-specific information, conservative assumptions shall be used that would be protective under reasonable worst-case situations. Level 1 approaches to be used shall be selected in consultation and with the approval of the department and may include the following:

(A) Wildlife exposure model. Soil concentrations that are protective of wildlife shall be established using the wildlife exposure model described in Table 7. The department may identify additional wildlife receptors to be included in the model on a site-specific basis, such as: locally-occurring native species known to be particularly sensitive to a contaminant of potential ecological

concern; species identified by the public as a site-specific concern; legally protected species likely to occur at, or visit, the site. Some potential exposure pathways are not included in Table 7 (e.g., inhalation, dermal contact). The department may require that an evaluation of risks through these or other pathways be included in the problem formulation if appropriate on a site-specific basis.

(B) Soil concentrations protective of soil biota or plants. Screening levels shall be established from a literature survey conducted in accordance with (5)(f)(iii)(C) and (5)(f)(iii)(D). Alternatively, a potentially liable person may elect to use the chemical indicator selection concentrations described in (5)(f)(iii)(A) as screening levels.

(C) Literature survey. Literature surveys should be thorough, critical and objective. The use of a commercial literature search service is an effective method for conducting a thorough survey. The department may also identify relevant articles, books or other documents that should be included in the survey. A list of relevant journals and other literature included in the survey shall be provided to the department. A tabular summary of information from all relevant studies shall be provided to the department in a report, and the studies used to select a proposed value shall be identified. Copies of literature cited in the table that are not in the possesion of the department shall be provided with the report. Appropriately conservative selections shall be used (e.g., lowest relevant LOAEL found in the literature).

(D) Toxicity reference values or screening concentrations established from the literature should represent the lowest relevant LOAEL found in the literature. In assessing relevance, the following principles should be considered:

- Literature screening values should be obtained from bioassays having test conditions as similar as possible to site conditions.
- The literature benchmark values or toxicity reference values should correspond to the exposure route being assessed.
- The toxicity reference value should be appropriate for the receptor being assessed and based on an endpoint with population level significance.
- The literature screening value or toxicity reference value should correspond to the appropriate exposure duration period (subchronic or chronic).
- The literature screening value or toxicity reference value should correspond to the chemical form being assessed.

(E) Soil bioassays. Level 1 bioassays may use sensitive surrogate organisms not necessarily found at the site provided that the test adequately addresses the concerns raised in the problem formulation step. For sites where risks to plant life are a concern, the test described in *Early Seedling Growth Protocol for Soil Toxicity Screening.* Ecology Publication No. 96-324 may be used. For sites where risks to soil biota are a concern, the test described in *Earthworm Bioassay Protocol for Soil Toxicity Screening.* Ecology Publication No. 96-327 may be used. Other bioassay tests approved by the department may also be used.

(F) Biomarker methods may be approved by the department if the measurements have clear relevance to issues raised in the problem formulation and the approach has a high probability of

detecting an adverse effect if it is occurring at the site.

(G) Other methods approved by the department.

(vi) Level 2 approaches. Level 2 approaches involve the collection of more site-specific information than for Level 1. The use of Level 2 approaches is voluntary. A potentially liable person may elect to base the ecological evaluation on results of a Level 1 assessment alone or to proceed to Level 2. Level 2 approaches to be used shall be selected in consultation and with the approval of the department and may include the following:

(A) Wildlife exposure model. Default values for the wildlife exposure model described in Table 7 may be replaced with values obtained from site-specific empirical studies to evaluate the toxicity or bioavailability of soil contaminants.

(B) Soil concentrations protective of soil biota or plants may be established using Level 2 soil bioassays.

(C) Soil bioassays. Level 2 bioassays should use species ecologically relevant to the site rather than standard test species used in a Level 1 bioassay evaluation. Species that do or could occur at the site are considered ecologically relevant.

(D) Site-specific field studies. Site-specific empirical studies that involve hypothesis testing should follow conventional statistical methods for data analysis. A conventional "no difference" null hypothesis should be developed (e.g., H_0: earthworm densities are the same in the contaminated area and the reference (control) area. H_A: earthworm densities are higher in the reference area than in the contaminated area.) In preparing a work plan for the proposed study, a power analysis should be included to evaluate the adequacy of the study design. Empirical studies should be designed to detect a 20% difference from the control with a Type II error rate of ≤20%. "Type II error" here means the failure to detect an existing biological effect of the soil contamination. Other methods, including best professional judgment, for insuring the adequacy of a proposed study to detect an existing adverse effect may be approved by the department on a case-by-case basis.

(E) Other methods approved by the department. The department encourages proposals for the use of new and innovative empirical methods. If approved, this information shall be made available by the department to interested persons.

(F) Uncertainty analysis. Discussion of uncertainty should identify and differentiate between uncertainties that can and cannot be quantified, and variability. The discussion should describe the range of potential ecological risks from the hazardous substances present at the site, based on the toxicological characteristics of the substances, and evaluate the uncertainty regarding these risks. Potential methods for reducing uncertainty should also be discussed, such as additional studies or post-remedial monitoring. If multiple lines of independent evidence have been developed, a weight of evidence approach may be used in characterizing uncertainty. A weight of evidence approach should include a balance in the application of literature, field, and laboratory data, recognizing that each has particular strengths and weaknesses. Site-specific data should be given greater weight than default values or assumptions where appropriate.

(g) The department shall consider proposals for modifications to default

values provided in this section based on new scientific information in accordance with WAC 173-340-702(14).

(h) Substitutions of receptor species in the wildlife exposure model described in Table 7 may be made subject to the following conditions:

(A) There is scientifically supportable evidence that a receptor identified in Table 7 is not characteristic of the ecoregion where the site is located.

(B) The proposed substitute receptor is characteristic of the ecoregion where the site is located and will serve as a surrogate for wildlife species that are, or may become exposed to soil contamination at the site. The selected surrogate should be a species that is expected to be vulnerable to the effects of soil contamination relative to the current default species because of high exposure or known sensitivity to chemicals found in soil at the site.

(C) Scientific studies concerning the proposed substitute receptor species are available in the literature to select reasonable maximum exposure estimates for variables listed in Table 7.

(D) In choosing among potential substitute receptor species that meet the criteria in (B) and (C), preference should be given to the species most ecologically similar to the default receptor being replaced.

(E) Unless there is clear and convincing evidence that they are not characteristic of the ecoregion where the site is located, the following groups shall be included in the wildlife exposure model: a small mammalian predator on soil-associated invertebrates, a small avian predator on soil-associated invertebrates, and a small mammalian herbivore.

(F) If screening levels calculated using the modified wildlife exposure model exceed those calculated using the default model described in Table 7, the ecological evaluation report shall include an assessment of whether it is biologically reasonable to expect such a difference.

(i) **Changes to the list of Tier II Priority Contaminants of Ecological Concern.** The department may add or delete a chemical from the list of Tier II Priority Contaminants of Ecological Concern provided in Table 6 after a thorough review of information from previous site investigations and consideration of the following:

(A) Whether the chemical been detected in contaminated soil.

(B) Whether the chemical has consistently been found only at concentrations well below the Tier II screening concentrations, and are there technically defensible reasons for concluding that the chemical is very unlikely to occur at higher concentrations at contaminated sites in Washington state.

(C) Whether there is a suitable surrogate chemical available on the current list.

(D) Whether there is reliable evidence that the chemical has not been manufactured, sold, or used in Washington state.

(E) Whether there is convincing evidence from a review of the results from ecological evaluations conducted in Washington state that the chemical does not pose a threat to the environment at soil concentrations below those established for the protection of human health. In making this determination, Ecology will consider the number and quality of the ecological

evaluations conducted for this chemical and whether a soil concentration established in a future site-specific human health risk assessment might not be environmentally protective.

(F) Whether the addition is needed to correct a deficiency in the overall environmental protectiveness of the Tier II soil evaluation process.

(G) Whether there is sufficient information to provide a basis for developing Tier II screening concentrations and whether the chemical meets at least one of the following criteria:

- Highly persistent in the environment; or
- High potential for bioaccumulation in the environment; or
- High toxicity to wildlife.

(H) The department will provide notice in the site register that it is considering adding or deleting a chemical from the Tier II Priority Contaminants List. Interested parties may submit technical information (e.g., toxicological studies from the peer-reviewed scientific literature) for the agency to consider in consultation with the Model Toxics Control Act Science Advisory Board.

Table 4
Tier I Ecological Evaluation of Soil

The following criteria apply to existing conditions at the time of site discovery and reporting (WAC 173-340-300). They should not be used for remedial decisions, which are subject to requirements in WAC 173-340-360.

1a) Does the soil contamination include any of the following substances listed below?[a] Chlorinated dioxins or furans PCB mixtures (polychlorinated biphenyls) DDT, DDE or DDD Aldrin Chlordane Dieldrin Endosulfan Endrin Heptachlor Benzene hexachloride Toxaphene Hexachlorobenzene Pentachlorophenol Pentachlorobenzene	If "no", proceed to 1b). If "yes" or "don't know" proceed to line 2).
1b) Is there less than 1.5 acres of contiguous undeveloped land[b] within 500 feet of the area of contamination?	If "yes", no further evaluation is required. If "no", or "don't know" proceed to line 2).
2) Is all of the soil contamination at least 6 feet below the soil surface?	If "yes", no further evaluation is required. If a further evaluation is not conducted, institutional controls may be needed to ensure that the contamination will remain at least 6 feet below the soil surface (see WAC 173-340-440). If "no", or "don't know" proceed to line 3).

3) Is all of the soil contamination covered by existing buildings, roads or pavement to preclude exposure by plants or wildlife to the contaminated soil?	If "yes", no further evaluation is required. If a further evaluation is not conducted, institutional controls may be needed to ensure that the exposure barrier continues to remain in place (see WAC 173-340-440). If "no", or "don't know" proceed to line 4).
4) Are there other existing physical barriers that prevent plants and wildlife from being exposed to the soil contamination?	If "yes", no further evaluation is required. If a further evaluation is not conducted, institutional controls may be needed to ensure that the exposure barriers continue to remain effective (see WAC 173-340-440). If "no", a further evaluation is required (WAC 173-340-709(5)(d)).

[a] This list does not imply that sampling must be conducted for each of these chemicals at every site. Sampling should be conducted for those chemicals that might be present based on available information, such as current and past uses of chemicals at the site.

[b] "Undeveloped land" means land that is not covered by existing buildings, roads, paved areas or other physical barriers that would prevent wildlife from feeding on plants, earthworms, insects or other food in or on the soil.

Table 5
Tier II Ecological Evaluation of soil - Habitat calculation [a]

1) Estimate the area of undeveloped land to the nearest 1/2 acre (1/4 acre if the area is small). From the table below, find the number of points corresponding to the area and enter this number in this box.	
Area (acres) / Points 0.25 or less / 4 0.5 / 5 1.0 / 6 1.5 / 7 2.0 / 8 2.5 / 9 3.0 / 10 3.5 / 11 4.0 or more / 12	
2) Is this is an industrial or commercial property? (Yes = 3, No = 1)	
3) Enter a score for the habitat quality of the undeveloped land, using the rating system shown below [b]. (High = 1, Intermediate = 2, Low = 3)	
4) Is the undeveloped land likely to attract wildlife? (Yes = 1, No = 2)[c]	
5) Are there any of the following soil contaminants present: chlorinated dioxins/furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, pentachlorobenzene? (Yes = 1, No = 4)	
6) Add the numbers from lines 2 through 5. If line 6 is larger than line 1, the ecological exposure area is below the criterion value (see 173-340-709(5)(e)(i)(A)).	

[a] This analysis applies to contiguous undeveloped land (include contaminated soil on undeveloped land and undeveloped land within 500 feet of the soil contamination). "Undeveloped land" means land that is not covered by existing buildings, roads, paved areas or other barriers that will prevent wildlife from feeding on plants, earthworms, insects or other food in or on the soil. It is expected that these assessments will be undertaken by a qualified field biologist. If this is not the case, enter a conservative score (1) for each of these questions.

[b] Habitat rating system. Rate the quality of the habitat as high, intermediate or low based on your professional judgment as a field biologist. The following are suggested factors to consider in making this evaluation:

Low: Bare soil or early successional vegetative stands; vegetation predominantly noxious, nonnative, exotic plant species or weeds. Areas severely disturbed by human activity, including intensively cultivated croplands. Areas isolated from other habitat used by wildlife.

High: Area is ecologically significant for one or more of the following reasons: Late-successional native plant communities present; relatively high species diversity; used by an uncommon or rare species; priority habitat (as defined by the Washington Department of Fish and Wildlife); part of a larger area of habitat where size or fragmentation may be important for the retention of some species.

Intermediate: Area does not rate as either high or low.

[c] Indicate "yes" if the area attracts wildlife or is likely to do so. Examples: birds frequently visit the area to feed; evidence of high use by mammals (tracks, scat, etc.); habitat "island" in an industrial area; unusual features of an area that make it important for feeding animals; heavy use during seasonal migrations.

Table 6
Tier II Priority Contaminants of Ecological Concern

Priority contaminant	Tier II screening level (mg/kg) (unrestricted land use).	Industrial/commercial Tier II screening level (mg/kg).
METALS:		
Antimony		
Arsenic	95 mg/kg	260 mg/kg
Barium		
Beryllium		
Cadmium	25 mg/kg	36 mg/kg
Chromium III		
Chromium VI		
Cobalt		
Copper	140 mg/kg	550 mg/kg
Lead	220 mg/kg	220 mg/kg
Magnesium		
Manganese		
Mercury, inorganic	9 mg/kg	9 mg/kg
Mercury, organic	0.6 mg/kg	0.6 mg/kg
Molybdenum		
Nickel		
Silver		
Tin		
Vanadium		
Zinc	270 mg/kg	570 mg/kg
OTHER CHEMICALS:		
Selenium		
D-n-butyl phthalate		
Bis (2-ethylhexyl) phthalate		
Benzo(a)pyrene	30 mg/kg	300 mg/kg
Acenaphthene		

PESTICIDES:		
Aldicarb/aldicarb sulfone		
Aldrin		
Carbofuran		
Chlordane		
Chlorpyrifos/chlorpyrifos-methyl		
DDT/DDD/DDE	1 mg/kg	1 mg/kg
Dieldrin		
Endosulfan		
Endrin		
Heptachlor/heptachlor epoxide		
BHC (incl. lindane)	3 mg/kg	3 mg/kg
Parathion/methyl parathion		
Toxaphene		
Hexachlorobenzene		
Pentachlorophenol	11 mg/kg	11 mg/kg
OTHER CHLORINATED ORGANICS:		
PCBs	2 mg/kg	2 mg/kg
Dioxins	5E-06 mg/kg	5E-06 mg/kg
Chlorinated dibenzofurans	3E-06 mg/kg	3E-06 mg/kg
Pentachlorobenzene		
Hexachlorophene		

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[a] Caution on misusing Tier II screening levels. These values have been developed for use at sites that do not meet any of the Tier I criteria but where a more careful site-specific Tier III evaluation is not required. They not intended to provide conservative concentrations that would be protective of terrestrial ecological receptors at every site. Exceedances of the values in this table do not necessarily trigger requirements for cleanup action under this chapter. The table is not intended for other purposes, such as evaluating sludges or wastes.

This list does not imply that sampling must be conducted for each of these chemicals at every site. Sampling should be conducted for those chemicals that might be present based on available information, such as current and past uses of chemicals at the site.

Table 7
Wildlife exposure model for Tier III screening level evaluations[a]

SOIL

C_{Soil} Concentration of hazardous substance in soil (dry weight basis)
Units: mg/kg

PLANT

K_{Plant} Plant uptake coefficient (dry weight basis)
Units: mg kg^{-1} plant/mg kg^{-1} soil
Value: chemical-specific (see Table 8)

SOIL BIOTA
Surrogate receptor: Earthworm

BAF_{Worm} Earthworm bioaccumulation factor (dry weight basis)
Units: mg kg^{-1} worm/mg kg^{-1} soil
Value: chemical-specific (see Table 8)

$C_{Worm, DW}$ Concentration of hazardous substance in earthworm (dry weight basis)
Units: mg/kg
$C_{Worm, DW} = C_{Soil} \times BAF_{worm}$

MAMMALIAN PREDATOR
Surrogate receptor: Shrew (*Sorex*)

$P_{SB (shrew)}$ Proportion of contaminated food (earthworms) in shrew diet
Units: unitless
Value: 0.50

$FIR_{Shrew,DW}$ Food ingestion rate (dry weight basis)
Units: kg dry food/kg body weight - day
Value: 0.45

$SIR_{Shrew,DW}$ Soil ingestion rate (dry weight basis)
Units: kg dry soil/kg body weight - day
Value: 0.0045

$RGAF_{Soil, shrew}$ Gut absorption factor for a hazardous substance in soil expressed relative to the gut absorption factor for the hazardous substance in food.
Units: unitless
Value: chemical-specific (see Table 8)

T_{Shrew} Toxicity reference value for shrew
Units: mg/kd - day
Value: chemical-specific (see Table 8)

Home range 0.1 acres

AVIAN PREDATOR
Surrogate receptor: American robin (*Turdus migratorius*)

$P_{Worm, robin}$ Proportion of contaminated food (soil biota) in robin diet
Units: unitless
Value: 0.52

$FIR_{Robin,DW}$ Food ingestion rate (dry weight basis)
Units: kg dry food/kg body weight - day
Value: 0.20

$SIR_{Robin,DW}$ Soil ingestion rate (dry weight basis)
Units: kg dry soil/kg body weight - day
Value: 0.0208

$RGAF_{Soil, robin}$ Gut absorption factor for a hazardous substance in soil expressed relative to the gut absorption factor for the hazardous substance in food.
Units: unitless
Value: chemical-specific (see Table 8)

T_{Robin} Toxicity reference value for robin
Units: mg/kd - day
Value: chemical-specific (see Table 8)

Home range 0.6 acres

MAMMALIAN HERBIVORE
Surrogate receptor: Vole (*Microtus*)

$P_{Plant, vole}$ Proportion of contaminated food (plants) in vole diet
Units: unitless
Value: 1.0

$FIR_{Vole,DW}$ Food ingestion rate (dry weight basis)
Units: kg dry food/kg body weight - day
Value: 0.315

$SIR_{Vole,DW}$ Soil ingestion rate (dry weight basis)
Units: kg dry soil/kg body weight - day
Value: 0.0079

$RGAF_{Soil, vole}$ Gut absorption factor for a hazardous substance in soil expressed relative to the gut absorption factor for the hazardous substance in food.
Units: unitless
Value: chemical-specific (see Table 8)

T_{Vole} Toxicity reference value for vole
Units: mg/kd - day
Value: chemical-specific (see Table 8)

Home range 0.08 acres

TIER III SCREENING LEVEL SOIL CONCENTRATIONS FOR WILDLIFE[b]

(1) MAMMALIAN PREDATOR:

$SL_{MP} = (T_{Shrew})/[(FIR_{DW,\ shrew} \times P_{SB\ (shrew)} \times BAF_{Worm}) + (SIR_{Shrew,DW} \times RGAF_{Soil,\ shrew})]$

(2) AVIAN PREDATOR:

$SL_{AP} = (T_{Robin})/[(FIR_{DW,\ robin} \times P_{SB\ (robin)} \times BAF_{Worm}) + (SIR_{Robin,DW} \times RGAF_{Soil,\ robin})]$

(3) MAMMALIAN HERBIVORE:

$SL_{MH} = (T_{Vole})/[(FIR_{DW,\ vole} \times P_{Plant,\ vole} \times K_{Plant}) + (SIR_{Vole,DW} \times RGAF_{Soil,\ vole})]$

[a] Substitutions for default receptors may be made as provided for in 173-340-709(5)(g). If a substitute species is used, the values for food and soil ingestion rates, and proportion of contaminated food in the diet, may be modified to reasonable maximum exposure estimates for the substitute species based on a literature search conducted in accordance with 173-340-709(5)(f)(v)(C).

Additional species may be added on a site-specific basis as provided in 173-340-709(5)(f)(v)(A).

The department shall consider proposals for modifications to default values provided in this table based on new scientific information in accordance with 173-340-702(14).

[b] Use the lowest of the three concentrations calculated as the wildlife screening value.

Table 8
Default values for selected hazardous substances[a]

Substance	BAF_{Worm}	Toxicity reference value (mg/kd - d) Shrew	Vole	Robin
INORGANIC SUBSTANCES:				
Antimony				
Arsenic III	1.16	1.89		
Arsenic V	1.16			22
Barium				
Beryllium				
Cadmium	4.6	15		20
Chromium III				
Chromium VI				
Cobalt				
Copper				
Lead				
Magnesium				
Manganese				
Mercury				
Molybdenum				
Nickel				
Silver				
Selenium				
Tin				
Vanadium				
Zinc				
ORGANIC CHEMICALS:				
Acenaphthene				
Aldicarb/aldicarb sulfone				
Aldrin				
Benzo(a)pyrene				
BHC (incl. lindane)				
Bis (2-ethylhexyl) phthalate				
Carbofuran				
Chlordane				
Chlorpyrifos/ chlorpyrifos-methyl				
D-n-butyl phthalate				
DDT/DDD/DDE				
Dibenzofuran				
Dieldrin				
Dioxins				
Endosulfan				
Endrin				
Heptachlor/heptachlor epoxide				
Hexachlorobenzene				
Hexachlorophene				
Parathion/methyl parathion				
PCBs				

Pentachlorobenzene
Pentachlorophenol
Toxaphene

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[a] Level 1 (screening level) evaluation. For hazardous substances not shown in this table, use the following default values. Alternatively, use values established from a literature survey conducted in accordance with 173-340-709(5)(f)(v)(C) and approved by the department.

K_{Plant}: Metals (including metalloid elements): 1.01

Organic chemicals: $10^{(1.588-(0.578*\log Kow))}$

where log K_{ow} is the logarithm of the octanol-water partition coefficient

BAF_{Worm}: Metals (including metalloid elements): 4.6

Non-chlorinated organic chemicals:

log $K_{ow} < 5$: 0.7

log $K_{ow} \geq 5$: 0.9

Chlorinated organic chemicals:

log $K_{ow} < 5$: 4.7

log $K_{ow} \geq 5$: 11.9

$RGAF_{Soil}$ (all receptors): 1.0

Toxicity reference values (all receptors): Values established from a literature survey conducted in accordance with 173-340-709(5)(f)(v)(C).

Level 2 evaluation. Site-specific values may be substituted for default values, as described below:

K_{Plant} Value obtained from empirical studies at the site.

BAF_{Worm} Value obtained from empirical studies at the site.

$RGAF_{Soil}$ (all receptors): Value established from a literature survey conducted in accordance with 173-340-709(5)(f)(v)(C)

Toxicity reference values (all receptors): For chemicals not included in this table, values should be established from a literature survey conducted in accordance with 173-340-709(5)(f)(v)(C) and approved by the department. Default toxicity reference values provided in this table may be replaced by a value established from a literature survey conducted in accordance with 173-340-709(5)(f)(v)(C) if it can be shown that the proposed value is more relevant to site-specific conditions (e.g., the value is based on a chemical form of the hazardous substance actually present at the site).